LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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The Problem of Lubrication in Mass Production

With Special Reference to Metal Forming Equipment and Grinding Machinery

THERE is somewhat of an entrancing meaning implied by the term "Mass Production" as used by industry today. It savors of huge machinery, of the manufacture of parts innumerable, of the intensive application of the ingenuity of man to the possibilities of employing the principles of mechanics.

Mass production is in fact the basis upon which the very economics of our industrial success are founded. The development of the automobile exemplifies this. When we think of the grinding of engine crankshafts at the rate of 80 to 125 a day per machine; of the pressing of steel fenders at a rate of 270 per machine hour; the real significance of "Mass Production" is brought out. The finished automobile, in one well-known plant at the rate of approximately 3,500 per day is astounding, but when we figure the multiplicity of parts involved the results seem well-nigh unbelievable.

In this matter of mass production two of the outstanding processes involve the punching or pressing of steel into suitable shapes for assembly into the finished product, and the grinding or finishing of metallic surfaces such as automotive engine crankshafts, camshafts, wrist pins, etc.

Lubrication of Metal Forming Machinery

The use of high pressure for the formation of metals has developed to an amazing extent along with the advancement of the automotive industry. The demand for mass or repetitive production has played an important part in this, especially in regard to power presses for the blanking, drawing, forming, forging and stamping of sheet metal.

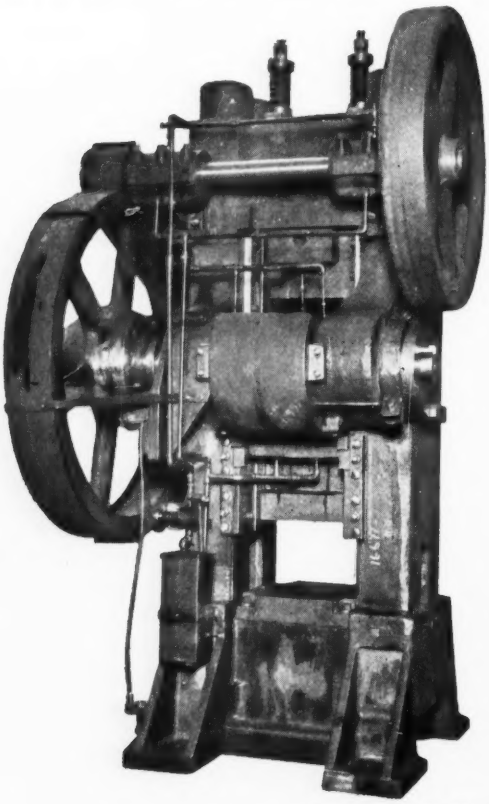
Machinery, wherein high pressures are involved, either more or less continuously, present a condition of potential wear which must never be overlooked, and lubricating requirements which entail the most careful selection and usage of lubricating oils and greases.

The extensive variety of machinery employed for the formation of metals at a high rate of production precludes detailed discussion of types. For the purpose in view this is not necessary, however; means of lubrication and the principles of operation will be of more particular interest in connection with a study of lubricating requirements.

Inasmuch as pressure is the ultimate factor in the operation of the metal press, etc., it is well

to consider the working elements of the machinery involved and study the effect which such pressure may have upon the lubricating films.

On the metal press, for example, there will be



Courtesy of E. W. Bliss Co.

Fig. 1—A high speed press equipped with a Brown & Sharpe system of pressure lubrication. Note circulating piping and oil reservoir.

constant normal pressures on the back shafts, with high intermittent pressures on the main bearings. These latter under working conditions will, in the majority of cases, run about four to five thousand pounds per square inch.

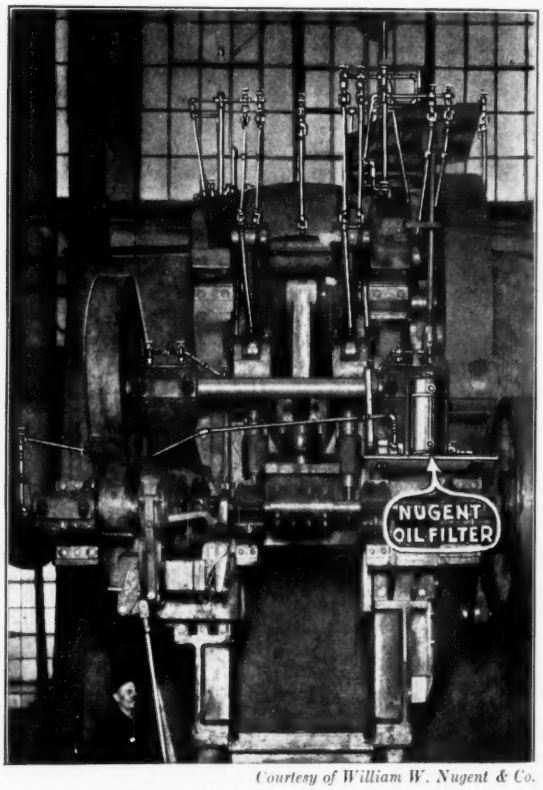
In general, this may be noted as reactionary pressure, or, in other words, the pressure which reacts back through the working parts as the press, slide, ram or other particular metal forming element performs its function. When such a machine is idling reaction or back pressure will frequently be comparatively low, even though a potential working pressure of thousands of pounds per square inch may be available.

Relation of Pressure to Lubrication

Pressure is one of the salient factors which require consideration in the solution of any lubricating problem, and the selection of the right lubricant. It is evident that under average conditions the greater the existing or operating pressure between any two wearing elements, the heavier or more viscous must be the lubricating film in order to prevent metal-to-metal contact. This holds true whether bearings, gear teeth or chain link connections are involved.

The logical effect of pressure will be a tendency towards the squeezing-out of the lubricating film from between the wearing surfaces in question. The essential solution to this problem will be proper grooving and adequate bearing area. On the other hand, with certain types of wearing elements the danger of impaired lubrication due to pressure can be partially prevented by enclosed construction, and the operating of the parts in a bath or flood of lubricant. Relative to the development of such pressures, however, it must be remembered that the period of maximum intensity is relatively brief.

In other cases, pressure can be met with pressure, the lubricant being maintained within the clearance spaces under the prevailing pressure of some form of pumping device. This is, however, impracticable on open-ended bearings.



Courtesy of William W. Nugent & Co.

Fig. 2—Back view of a drawing press showing the oil filter and pump installation, and the series of oil piping and connections to the various wearing elements.

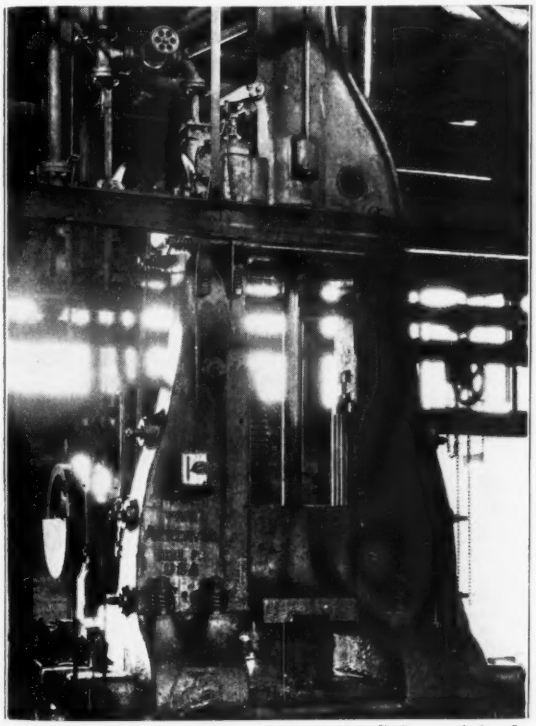
Conditions Involved

But, irrespective of the means of application, a certain degree of adhesiveness and sufficient viscosity must be prevailing characteristics of

the lubricant itself. To make any other than generalized statements as to the viscosity range would be unwise. Too much will depend upon conditions of construction, operation and means of application. It will be far better to study these latter conditions in order that the severity of the duty may be realized. With such knowledge as a basis, and an understanding of what is actually involved when we speak of viscosity, etc., the problem of subsequently selecting either oils or greases to function effectively should be materially simplified.

It is practicable to use either oil or grease for the lubrication of many of the wearing elements of metal forming machinery. The ultimate factor will involve the type of lubricating equipment provided, the operating conditions such as speed and bearing pressures, and details of construction such as manner of grooving.

By virtue of the size, number of bearings, and bulky nature of such machines, it has been deemed advisable in many cases to provide for some form of positive, automatic lubrication. Greater convenience should thereby result,



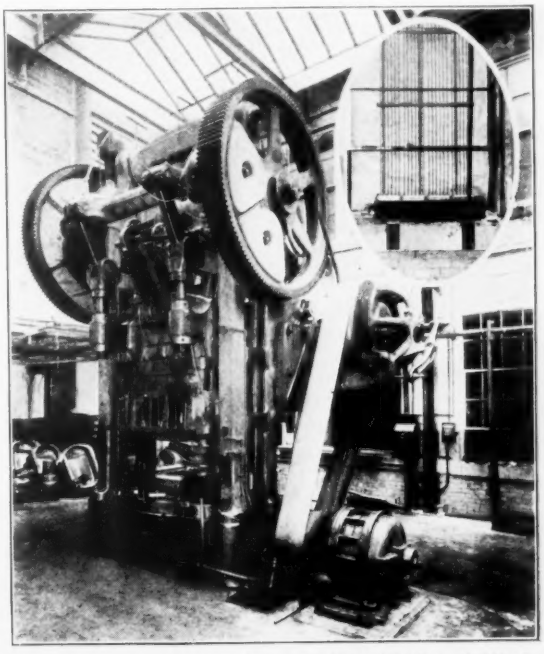
Courtesy of S. F. Bowser & Co., Inc.

Fig. 3—An Erie steam hammer with its steam cylinder served by a ratchet drive mechanical force feed lubricator. This latter is located just above the builders' name.

with frequently marked savings in labor due to reduction in the amount of attention necessary.

LUBRICATING EQUIPMENT

Means or equipment for automatic lubrication will be usually confined to the bearings of the average press. Where gears are involved for driving or speed reduction purposes they will frequently be but partly guarded or encased. When speeds are not excessive bath



Courtesy of McCord Radiator & Mfg. Co.

Fig. 4—Showing a Ferracute Toggle Press equipped with a mechanical force feed lubricator. The particular advantages of the latter are claimed to be visibility, ease in flushing and positiveness of action.

lubrication may be possible, using a comparatively fluid gear lubricant. Under higher speed conditions, however, or where the lower part of the casing may not be sufficiently oil-tight, a more inert lubricant may be advisable.

A high degree of adhesiveness is essential under such conditions; this is a characteristic of those straight mineral lubricants of from 1000 to 2000 seconds Saybolt viscosity at 210° F. which have proven so particularly adaptable to gear service of this nature. Normally, such lubricants will be applied by hand, but they are so enduring in service and so resistant to the squeezing-out effects of high tooth pressures, and the throwing-off effects of centrifugal force that re-lubrication is only essential at infrequent intervals.

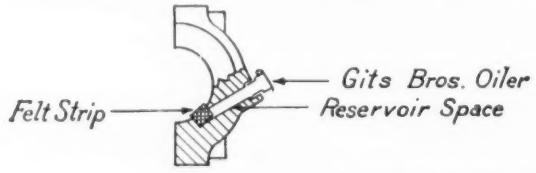
It is interesting to state, however, that considerable attention has been given to the development of mechanical means of applying such lubricants to press gears.

It is claimed that such equipment will involve marked savings in labor and lubricant.

On the other hand, a more or less extensive and perhaps costly piping layout would have to be considered on most machines of this type.

The Mechanical Force Feed Lubricator

In order to maintain the requisite lubricating film within the clearance spaces of many types of press bearings, oil must be delivered in measured quantities under sufficient pressure



Courtesy of E. W. Bliss Co.

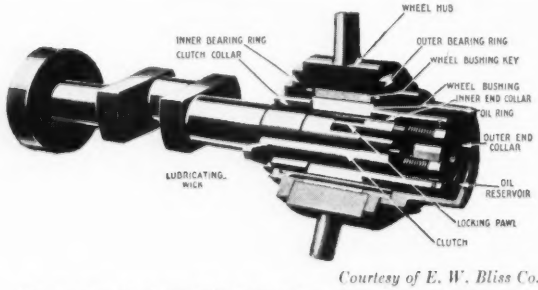
Fig. 5—Details of the main bearing cap of a typical press showing means of lubrication by use of an oiler and felt strip.

to counteract in part the operating pressures which prevail.

The mechanical force feed lubricator has been one type of equipment which has been found to be especially adapted to such service where oil is the most desirable lubricant.

Devices of this nature are operated under varying pressure by the machines to which they are attached. They can be built with a number of oil feeds, each being controlled by its individual pump in the oil reservoir. The mechanical force feed lubricator is a decidedly convenient and positive device, and equipped with separate visible feed lines to the respective bearings it makes possible the control and maintenance of an uninterrupted supply of oil at all times provided that periodic refilling is attended to. It is practicable furthermore, to equip such a lubricator with a return line, used oil being carried back to the reservoir for recirculation. In this way oil economy is increased.

Mechanical force feed lubricators, being practically always driven by the machinery which they serve, only function when the latter is in operation and at a proportional speed. The



Courtesy of E. W. Bliss Co.

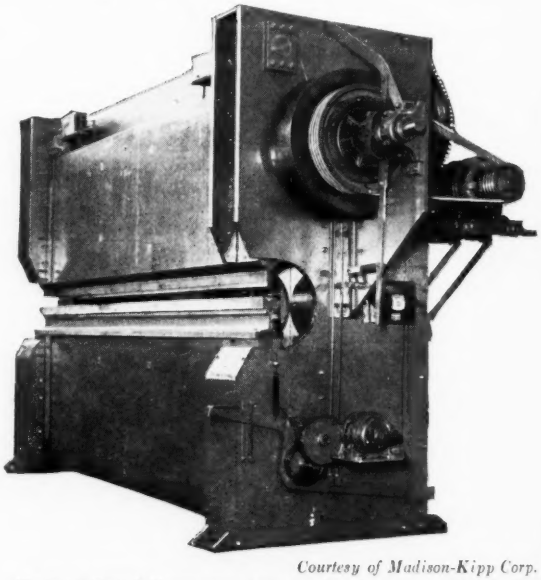
Fig. 6—Details of the Bliss Rolling Key Clutch with backing pawl. Note means of lubrication as explained.

pumping capacity and rate of oil feed is therefore variable. By suitable adjustment of the lubricator it can be very accurately regulated to meet whatever lubricating requirements may be involved.

The advantage claimed for the mechanical force feed lubricator as a one-time oi ing device is that a positive pre-determined supply of clean fresh oil can be furnished to the bearings in as nearly as possible the correct amount to meet the requirements of effective lubrication. Waste can, thereby, be reduced to a minimum and general conditions of cleanliness improved. As a rule there will be very little drip from bearings so lubricated.

Circulating Oiling Systems

The continuous circulation of oil through the bearings of certain types of metal forming equipment, such as the high speed punch press, for example, affords a very practical and eco-



Courtesy of Madison-Kipp Corp.

Fig. 7—A Dreis & Krump press brake equipped for pressure lubrication by means of a mechanical force feed oiler shown in upper left hand corner.

nomical way of automatically lubricating such parts with a minimum of labor or attention. As a rule a considerably greater volume of oil will be involved in a circulating system than in a mechanical force feed lubricator.

A typical circulating system will involve a suitable oil reservoir in the base of the machine, a pump for transmission of oil either to an overhead auxiliary tank, or directly to the bearings to be served, and the necessary distributing pipes to each of the latter. Each line should be fitted with a sight feed device and adequate means for individual adjustment of oil flow. Means will also be necessary for drainage or transmission of used oil back to the base reservoir or sump tank.

Such a system is advantageous in that it provides for sufficient settling of the oil to insure precipitation of the majority of any foreign

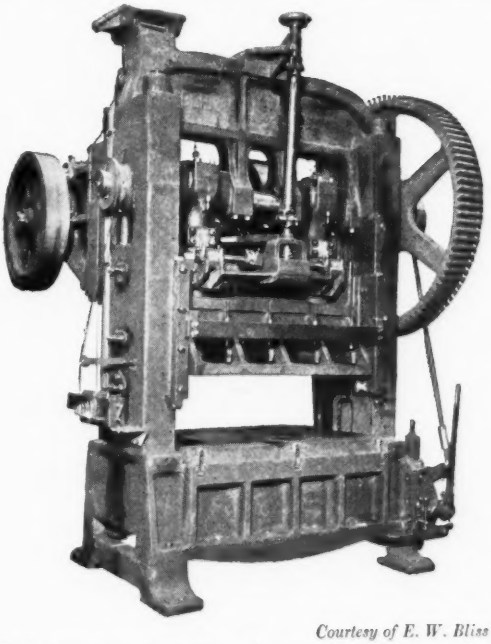
matter that may have been picked up by the oil in passage through the bearings. Furthermore, the latter are practically flood lubricated, which not only means that they will normally be washed free from accumulations of foreign matter, but also cooled to a certain extent.

It is also perfectly practicable to provide for adequate pressure either by gravity or pumping, to maintain a sufficient pressure on the oil films to in part serve to resist such operating or reaction pressures as may be involved on certain of the bearings.

Drip Lubrication

The sight feed oil cup and wick oiler are also claimed to give the requisite degree of lubrication. The former, of course, will involve individual lubrication of the respective bearings as a rule, with consequent need of individual attention as to filling and adjustment. Sight feed oilers, however, are advantageous in that they normally permit of observation of the oil content from the operating floor.

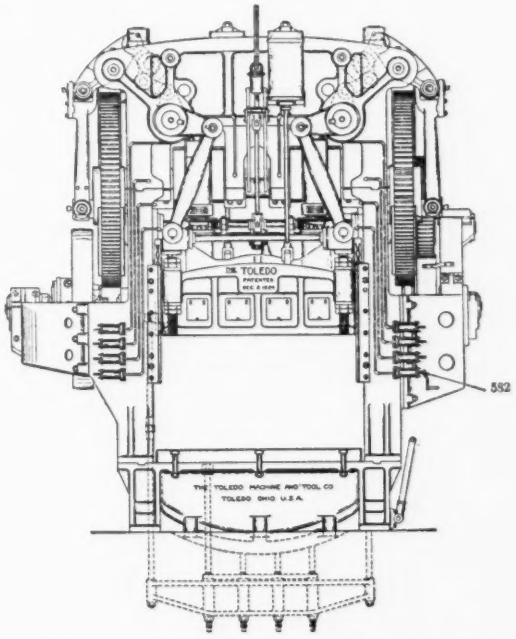
The wick feed oiler in turn can be of either the individual or manifold type. Each is economical from a labor-saving point of view, though they may perhaps involve oil waste if improperly designed, adjusted or controlled.



Courtesy of E. W. Bliss Co.

Fig. 8—Rear view of a double crank press equipped with a mechanical Manzel force feed oiler (shown at lower left side).

The manifold type can be built on very much the same lines as the wick oiler employed on certain classes of marine steam engines. Wick oiling on the whole is decidedly advantageous provided that the wicking is of proper texture and in good condition, for the wick will serve as an effective strainer to insure delivery of clean oil to the bearings. Periodic cleaning of wicks, of course, is advisable if the above is to be continuously maintained.



Courtesy of The Toledo Machine & Tool Co.

Fig. 9—Line sketch of a Toledo press equipped for grease cup lubrication of essential bearings. Note distributing piping and lubricators (No. 582).

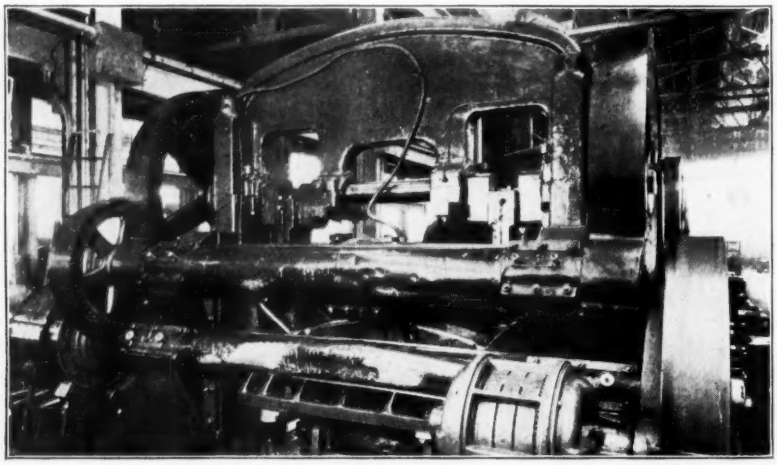
There are, however, many bearings on certain types of presses, etc., which will not require such positive means of lubrication. Usually they can be hand-oiled two or three times a day. To facilitate this the spring-cover type of oil cup is frequently installed.

Normally the same grade of oil as used in a mechanical force feed lubricator or circulating oiling system will adequately take care of such other wearing elements as may require drip or hand oiling. Such a product should be a highly refined, straight mineral oil having a viscosity range of from 200 to 400 seconds Saybolt at 100° F.

Pressure Grease Lubricators

Where heavier lubricants may be necessary for individual bearing lubrication, the use of grease, or a straight mineral product of approximately the viscosity of steam cylinder oil will often be advisable. Mechanical or hand pressure grease lubricators will handle such lubricants admirably. The pressure grease lubricator may be either of the hand or power type. For the use of the individual machine operator, the former is perhaps the most suitable device.

In large plants, however, where considerable metal forming equipment may be involved, the



Courtesy of Industrial Oil Equipment Co.

Fig. 10—A metal press in an automotive body plant equipped with "Gun-Fil" pressure grease lubricators. Note these latter on the central shaft bearing.

power lubricator will often be an adjunct as a time and labor saver.

Another noteworthy piece of equipment is the constant pressure grease lubricator for use in connection with the pressure grease gun. In effect it has been designed to eliminate the necessity for frequent re-lubrication. It is, in fact, as nearly positive and automatic as practicable over the length of time that its charge of grease will last. Lubricating equipment of this nature would be especially adaptable to service on crank bearings where hazards might be involved were hand oiling to be attempted.

Grease Cup Lubrication

In view of the necessity for a means of lubrication that will function relatively automatically and be capable of withstanding hard knocks, the grease cup is also extensively used on certain press shaft bearings. In some cases such bearings are located in dangerous and inaccessible positions, where regular oiling, or the filling of oil cups, etc., would be comparatively difficult or even impossible without complete shut-down.

Grease lubrication by means of the hand or spring regulated compression cup or the relatively automatic pin type of cup is therefore regarded by many engineers as an effective means of keeping such bearings operating with a minimum of care and the least amount of danger to operators.

Selection of Greases

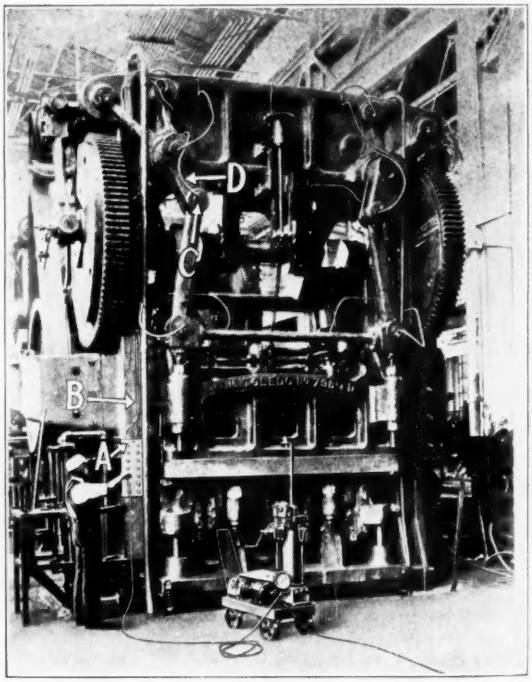
The requisite consistency of grease to use will be dependent upon the type and size of the bearings, the pressure involved and the variety of grease cup used.

Compression cups will, in general, function best on a medium grade of cup grease.

Pin-type cups, on the other hand, involving either temperature or a certain pumping action in the attainment of flow of the grease will require products of lighter consistency.

It is relatively impossible to make specific recommendations in this regard. Operating conditions, machine design and construction, temperatures involved and the class of labor available will all require individual consideration.

As a result the matter of grease lubrication should be discussed in detail with a capable lubricating engineer who is versed not only in the details of machine operation, but also intimately familiar with the capabilities of each



Courtesy of Carr Fastener Co.

Fig. 11—A Toledo press equipped for pressure grease lubrication. "A" indicates point of centralized lubrication showing Dot Nipples for attachment of pressure gun. "B" shows the gang distributing tubes. "C" is a typical universal joint for connecting lubricant channels with bearings of the toggle arms, rocker shafts, etc., and "D" is the flexible hose for the above.

of the several grades of greases available to choose from.

SLIDES AND GUIDES

The operation of certain types of metal forming machinery requires the use of slides or guides to carry the reciprocating elements and insure perfect and constant alignment in order that such cutting, stamping, perforating or forming as may be involved can be carried out with the desired accuracy. It is possible to adjust these slides on most machines, and in this way wear can be compensated for, unless, of course, it has been allowed to occur to an extreme.

Proper maintenance of adjustment, however, with adequate lubrication should assure of the development of minimum solid friction and wear.

In the lubrication of sliding surfaces pressure, speed, and the method of application of the lubricant are the essential factors which must be considered. The lubrication of practically any sliding surface wherein the action of gravity must be counteracted by the adhesiveness and body of the lubricating film will oftentimes be a comparatively difficult matter due to the wiping action of the reciprocating elements and the possibility of contamination of the intermittently exposed lubricating film with dust, dirt or metallic particles in many instances.

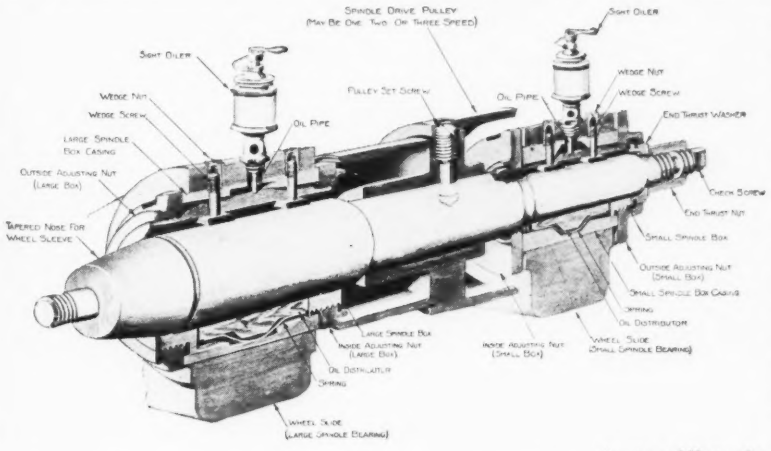
To adequately protect against these latter is practically impossible. The only solution of the problem and the best insurance against the development of an abnormal amount of wear is to select the lubricant most carefully from a viscosity or film body viewpoint and to apply it with adequate generosity to insure the flowing off of heavier, contaminating foreign matter.

Lubricating oils of medium to heavy viscosity will in general best meet the requirement on the average machine. There must be a certain amount of flood lubrication, especially where contamination may be excessive, and greases will as a rule be too retentive to function satisfactorily, even though their usage might reduce consumption to a certain extent.

In choosing the oil, that is in determining upon how much viscosity or body is essential, the operating pressure and temperature, as well as the prevailing clearance should be taken into consideration. It is difficult to state definitely just what the viscosity should be in measured terms, i. e., seconds Saybolt at 100 or 210° F. We are practically up against a cut-and-try proposition, depending upon existing conditions. As a rule, however, 300 to 750 seconds Saybolt at 100° F. should indicate the high and low limits. Such an oil should have a comparatively high adhesive characteristic, especially where wiping or thrust pressures may be high.

The Grinding Machine

Grinding is an especially interesting topic, if only from its effect upon subsequent lubrication of practically every wearing element in the average machine.



Courtesy of Norton Co.

Fig. 1—Details of a grinding machine spindle showing in particular the bearing construction, the oil distributors and the sight feed oilers.

Apart from this, however, as Dunbar so clearly notes,* the art of grinding has been so finely developed as to be practically an essential to the majority of our every-day necessities which must be produced in quantities.

The automobile is but an instance of this, but it is certainly a vital one to us all. Especially is it of interest when we realize that effective grinding will be the salient criterion in the development of the necessary finish of all wearing or frictional elements which must be effectively lubricated if operation is to be economical and efficient. In truth, the grinding machine is alone capable of reproducing its own accuracy of design and construction.

Of course, to bring this about, grinding machines themselves must be properly lubricated.

*"Grinding Service Far Reaching," by H. W. Dunbar, ABRASIVE INDUSTRY, Jan., 1926.

In fact, the features of positive automatic lubrication apply just as they do to those other machine tools such as the lathe, planer, milling machine and drilling machine, which were discussed in "Lubrication" for March, 1927. It is fitting, therefore, to discuss the grinding machine in its turn, and note the developments in automatic lubrication which the builders have proved to be essential and beneficial as an adjunct to mass production.

Courtesy of Builders Iron Foundry

Fig. 2—Details of a typical ball bearing as used in certain types of grinding machines.

CONDITIONS OF OPERATION

The modern grinding machine is built to operate over a wide range of speed conditions, dependent upon the type of work to be performed, the amount of stock to be removed by grinding, and the nature of the materials involved. By virtue of these speed requirements and the accuracy demanded, the utmost care and attention has been devoted to design and construction of driving mechanisms, wheel spindles, feed screws and wheel slide ways.

Accuracy and Rigidity Mandatory

Accuracy and rigidity are paramount requirements in any grinding machine intended for mass production service. These features are characteristic of the machine when it is first put into service, being the result of the cooperative efforts of the machine designer and tool builder. The continued maintenance of this accuracy and rigidity, however, is a problem for the operating engineer and lubricating specialist, for lubrication is, in fact, the secret of effective grinding and the ability to produce the maximum of results with the minimum of power requirement and development of friction.

THE MAIN DRIVE

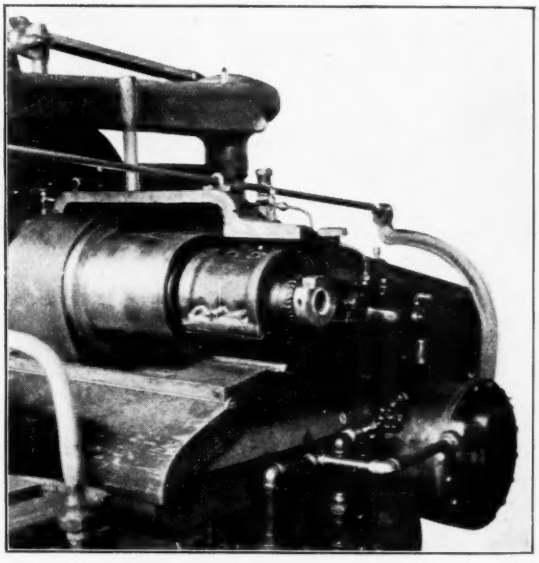
The main drive of the modern high speed grinding machine comprises either the belt or electric motor. The latter permits of greater flexibility in machine operation, and is claimed, furthermore, to involve more economical transmission of power.

Anti-Friction Bearings

Ball bearings, and in certain cases roller bearings, have been found to be adaptable by certain machine builders as a means of insuring effective operation of such elements as the idler and main drive shaft especially. This latter shaft is, in fact, the salient factor in the maintenance of effective operation of the wheel spindle. On the other hand, this spindle is regarded as the most important member from the viewpoint of lubrication, by virtue of its size, the heavy duty to which it is subjected, and the high speeds which frequently prevail.

Principles of Lubrication

The lubrication of anti-friction bearings is but a detail from the viewpoint of the amount of labor and attention involved. The important point is the original selection of the lubricant to be used, and the consideration of its characteristics as required by the principles of anti-friction bearing construction and operation.



Courtesy of Landis Tool Co.

Fig. 3—End view of a spindle showing essentials of the force feed oiling system. Note chain driven geared pump, the sight feed oiler and adjusting screw on top of the oil regulator.

Function of the Lubricant

In such bearings the purpose of lubrication is to facilitate as easy rolling as possible. To enable this, however, all the surfaces (which are of a highly polished nature) must be in as perfect condition as practicable. The lubricant

must, therefore, serve the dual purpose of both lubricating and protecting these surfaces against rusting, corrosion, pitting, or abnormal wear.

Clearance Requirements

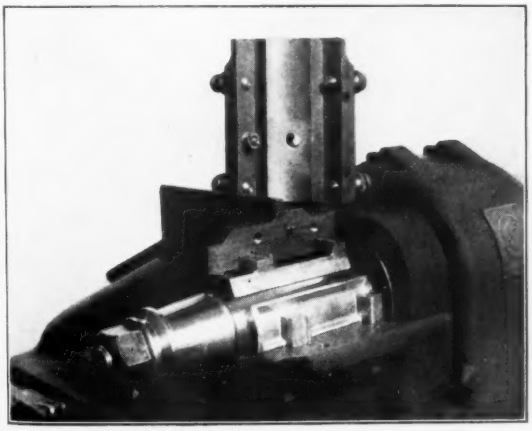
Minimum clearance, of course, is an aid to proper functioning of such bearings, for the occurrence of any play between the component parts would tend to set up a certain amount of pounding which would be detrimental to effective operation. In other words, all motion must be as nearly akin to perfect rolling as possible.

As a general rule, as light a lubricant should be used as can be successfully retained in such a bearing commensurate, of course, with the temperatures and pressures involved. Where practicable an oil with a viscosity of from 100 to 200 seconds Saybolt at 100° F. will be best.

The Use of Grease

Wherever there is possibility of oil leakage, however, or under conditions of dust, dirt or dampness it may be advisable to resort to grease as the lubricant. Greases furnish better seals against the entry of dust, dirt and moisture, thereby serving to protect the polished surfaces of the bearing elements in a very satisfactory manner.

Grease also can be very much more effectively retained in a non-oil-tight housing; on the other hand, dirt or grit that finds its way into a grease lubricating bearing, has no means of settling out, but is always held in suspension, being carried back into the bearing repeatedly.



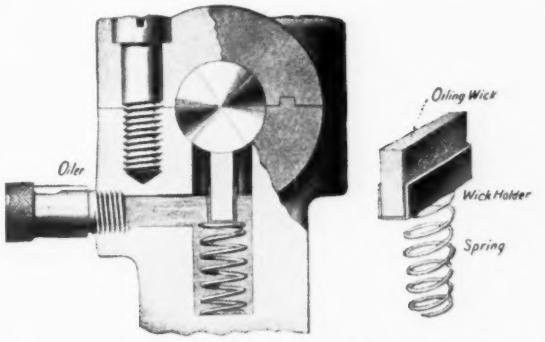
Courtesy of Norton Co.

Fig. 4—A grinding machine spindle bearing with cap removed to show the adjustable top bearing pieces.

THE GRINDING MACHINE SPINDLE

Adaptability of the Sight Feed Oil Cup

Where the grinding machine wheel spindle is built with plain or so-called sleeve-type bearings, in certain types, as illustrated by Fig. 1, the sight feed oil cup has been proven to afford the requisite degree of lubrication, especially where a wooden oil distributor is properly located within the bearing housing below the spindle. The three-part bearing is extensively used on certain of such machines, viz., a half box is located at the bottom and to the rear of the spindle housing. The top construction consists of two adjustable bearing segments. By means of suitable thumb-screws these latter can be readily adjusted to meet lubrication and pressure requirements without the necessity for stopping the spindle. Production is, therefore, not interfered with in the making of any normal adjustment.



Courtesy of Builders Iron Foundry

Fig. 5—Details of a wick oiling device adaptable to the lubrication of certain types of grinding machines.

Circulating Oiling also Practicable

Flood lubrication has also been developed to a marked degree, especially for the preservation of spindles. Mechanical or automatic circulation of the oil to the essential wearing parts can be admirably accomplished by means of a suitable chain driven pump, which is driven from the wheel spindle. There must, of course, be adequate reservoir space with such a system to carry the requisite volume of oil and provide for proper settling. In many machines the hollow wheel slide is used for this purpose; as well, it serves as a housing for the oil pump.

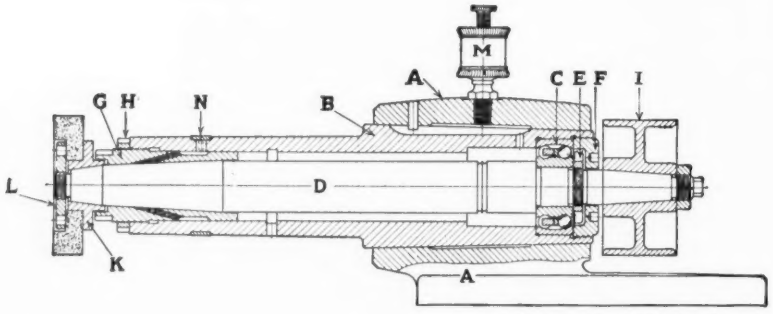
Cleanliness a Factor

Flood lubrication by means of oil circulation insures, perhaps, the greatest degree of operating cleanliness possible of attainment, for in addition to serving as a lubricant and coolant the oil will usually wash the entire system free of any accumulations of foreign matter. It is essential, however, that there be an ample quantity of oil in the system and sufficient volume in the reservoir to allow for precipitation or settling out of the majority of any

foreign matter which may have been taken up during circulation.

Minimum of Attention Required

Another advantage pertinent to such a system is that a minimum of attention is required,



Courtesy of The Heald Machine Co.

Fig. 6—Details of a typical drip-oiled spindle bearing on a grinding machine. Note the S. K. F. self-aligning ball bearing, "C". A sight feed oiler "M" serves as the primary means of lubrication, along with a hand-oiler "N".

and normally but little adjustment. Relative to the latter it is interesting to note that usually there will be provision for same, a suitable valve being installed in the bearing cap or at some other accessible point. On grinding machines, where oil circulation adjustment is provided for in the bearing cap, an observation window or glass located in front of the bearing enables the operator to note his oil flow at all times.

FLUSHING AND CLEANING OF BEARINGS

In order to insure the maximum of protection from any grinding machine lubricant it is absolutely essential to keep the lubricating system as free from foreign matter as is consistently possible, according to the operating conditions and bearing construction.

There is always a possibility of entrance of impurities, especially where bearings may not be properly sealed. It is a matter of decided importance for we can realize that continued churning of abrasive foreign matter with oil and its passage through plain bearing clearance spaces or in intimate contact with highly polished balls and raceways will ultimately prove the ruination of spindle or main drive bearings and their respective elements.

Sealing of Bearings Not Always Practicable

In view of the fact that it is not always possible to effect the requisite degree of sealing or to depend upon the seal being in good working order at all times, grinding machine bearing lubricating systems should be flushed and cleaned at periodic intervals. The frequency will, of course, depend upon the design of the bearing, the type of seal, the lubricant used and the extent to which dust and dirt are present.

Type of Bearing a Factor

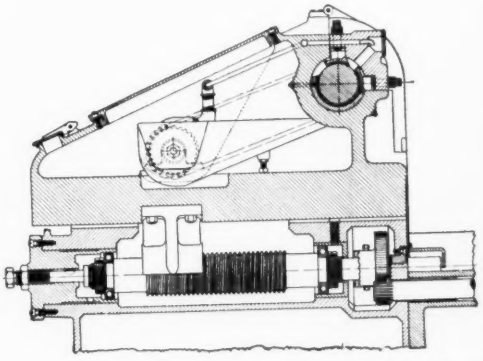
Systems served by sight feed oilers will in general require more frequent attention than ball bearings, due to the fact that their housings may be less carefully designed. With the former cleaning may be necessary or advisable at periods ranging from every two weeks to every several months.

With ball or roller bearings once or twice a year is sufficient, unless operating conditions are especially dirty.

On the other hand, antifriction bearings are more delicate from the viewpoint of construction, and therefore the lubricant should not be allowed to become as contaminated as is permissible with other types of bearings.

Advantage of Circulating or Flood Lubrication

Circulating oiling systems possess natural advantages in that the flood of oil which is constantly passing through the bearings tends to wash out any grit, dirt, dust or metallic particles that may have gained entry. As a result,



Courtesy of Norton Co.

Fig. 7—Cross section of the wheel slide of a grinding machine. Note details of chain driven oil pump, feed screw and spindle bearing. Oil piping to latter (at top of drawing) can also be traced.

wear is reduced to a minimum, just as long as the oil in the system does not become so highly contaminated as to be unable to precipitate such foreign matter during its period of so-called rest.

This flooding of bearings, by virtue of its

washing action, naturally gives rise to gradual accumulation of foreign matter, therefore the condition of the oil should be carefully watched and the system drained as soon as any excess of dirt becomes apparent.

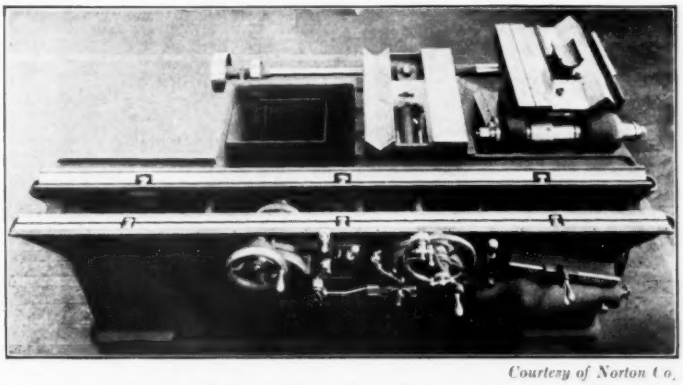
SELECTION OF LUBRICATING OILS

Spindles

For all normal conditions of grinding machine spindle operation it will be practicable to use a light to medium bodied straight mineral spindle or machine oil, the degree of refinement depending to a large extent upon the type of lubricating system.

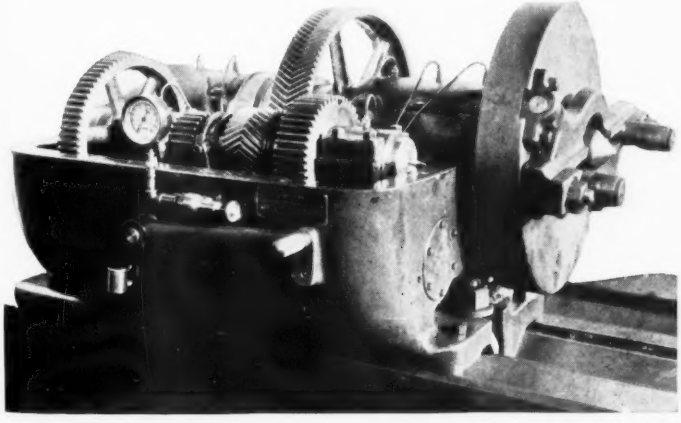
In sight feed oilers as used for spindle lubrication on many machines an oil of from approximately 100 to 200 seconds Saybolt at 100° F. will adequately fill the clearance spaces and prevent abnormal vibration should these latter be comparatively high. Relative to the rate of oil feed, it is interesting to note that the Norton Company recommends adjustment of sight feed oilers to deliver from about 7 to 10 drops a minute.

It is practicable to use this same grade of oil for the spring-actuated wick-oiled bearing. (Fig. 5). In the ring oiling device, however, as illustrated by Fig. 10, a somewhat heavier product will be necessary, the viscosity ranging from 200 to 300 seconds.



Courtesy of Norton Co.

Fig. 9—Top view of a grinding machine with spindle removed showing the "V's", tableways and other flat bearing surfaces. Note the roller oilers which serve the former and method of grooving of the latter.



Courtesy of Landis Tool Co.

Fig. 8—The headstock of a roll grinder equipped for pressure lubrication. The base forms the oil reservoir. A gear pump distributes the oil, the pressure of which is regulated by a relief valve.

Circulating Systems

Grinding machine bearings served by circulating systems can normally function on an oil of similar viscosity as mentioned for the spindle bearings. Re-usage of oil by circulation, however, imposes a very important requirement upon any oil for such service. In other words, it must readily separate from water or other foreign matter, and not tend to develop emulsions to any extensive degree.

For this reason attention must be paid to the degree of refinement of any oil under consideration. That is, an oil should be used which has been freed by filtration of those hydro-carbon constituents which may lead to subsequent emulsification, especially when the oil is agitated in the presence of air, and perhaps in contact with water or particles of metallic foreign matter. As a rule a viscosity range of from 100 to 200 seconds Saybolt at 100° F. will meet requirements.

Gear Shaft Bearings, etc.

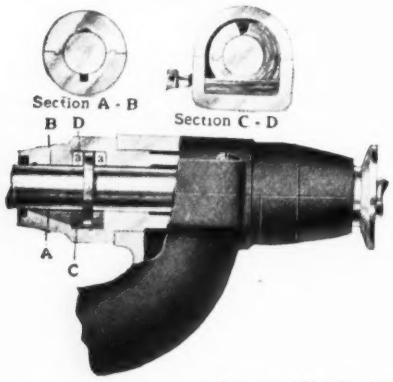
For those other wearing elements in the average grinding machine, including reversing mechanisms with their essential gears, cams and bearings, an oil should be used which will meet the requirements of both hand and bath lubrication. This latter is prevalent in many reversing mechanism housings. The oil cup, however, prevails on the majority of the other general machine bearings.

The duty involved is not severe. Therefore, a medium bodied straight mineral machine oil will, as a rule, serve the purpose satisfactorily, the viscosity range being from 200 to 400 seconds Saybolt at 100° F.

Flat Bearing Surfaces

There may, however, frequently be a problem in the lubrication of flat bearing surfaces such

as V's and table ways, due to the varied pressures which may be developed. For this reason the utmost care should be paid to selection of



Courtesy of Builders Iron Foundry

Fig. 10—Details of a ring oiler adaptable to the bearings on certain types of grinding machines.

the oil to be used, and the extent of viscosity or body required.

Lubrication of such surfaces can be accomplished by oil cups and suitable grooving of the ways, or by the installation of rollers located in depressions which can be kept full of oil. These latter are more automatic, for at each passage of the slide the respective rollers carry a film of oil up to the surfaces of contact, in much the same manner as a ring-oiler would lubricate a plain bearing.

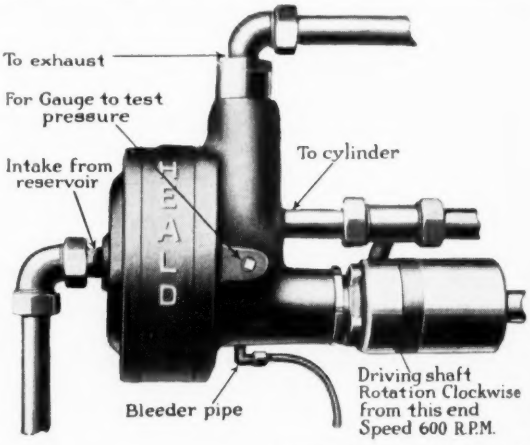
The viscosity range to meet the pressure conditions of slide operation must of necessity be wide. Oftentimes, on smaller grinding machines it can be as low as 300 seconds Saybolt at 100° F. On the other hand, larger machines such as those designed for the grinding of steel mill rolls may require a lubricant as heavy in body as a steam cylinder oil, the actual viscosity being perhaps as high as 130 seconds Saybolt at 210° F.

In closing it is well to state that the selection of such lubricants is practically a matter of cut and try, depending upon the experience of the machine operator and his ability to estimate pressures and note the extent to which any wear may take place.

CONCLUSION

It has, of course, been impossible to treat this important matter of Lubrication of Mass Production Machinery in any but a cursory manner. An effort has been made, however, to discuss the salient factors which must be considered if effective lubrication is to be maintained. Particular attention has been given to the selection of the illustrations, for it is felt that by showing the various systems of lubrication which have been proven to be adaptable, a clearer understanding will be afforded the reader.

A study of these in conjunction with the text and an insight into the essential characteristics



Courtesy of The Heald Machine Co.

Fig. 11—The "Hy-duty" oil pressure pump employed for circulation of oil in the constant pressure control of an internal grinding machine.

of the lubricants should be of inestimable value to the operator of Mass Production Equipment whatever the process involved may be.

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